MEMBRANE FILTRATION INSTALLATION
at
OBERTI OLIVE DIVISION
of
TRI VALLEY GROWERS

Analysis of Business, Environmental, and Energy Issues

Prepared on behalf of Tri Valley Growers

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1. Executive Summary

Overview

In 1997 Tri Valley Growers (TVG) completed installation of an $8.4 million membrane filtration system on the wastewater portion of the Oberti Olive Plant in Madera, California. The facility is rated to produce 20,000 ton/year of black ripe olives. The installation gave TVG the first "zero-discharge" olive plant in California and in the United States. TVG installed the membrane system to meet increasingly stringent environmental regulations on its 160 acres of evaporation ponds. Alternatively, TVG faced either an unacceptable $40 million wastewater-pond upgrade cost or closing the Oberti Plant.

TVG's new filtration system reuses 80% of the plant's process water flow, with nearly 20% of the remaining flow being concentrated and sold as animal feed. Olive processing changes, identified during the design phase, cut plant needs for water and chemicals. As a result, well-water pumping is down by 92% and wastewater flows dropped similarly.

However, the plant operators have experienced a number of startup and operational hurdles. Startup required nearly two years before all subsystems operated acceptably; cleaning costs are four times higher than expected. In spite of these higher-than-expected operating costs, the project is a success because chemical costs for olive processing dropped greatly and the plant remains open, saving 575 jobs.

Figure 1 shows the membrane filtration bank.

Figure 1: Membrane Filtration Bank

This report summarizes key results that other food processing plant owners can leverage to determine applicability of membrane filtration in their plants. The report includes eight sections:

- *Executive Summary ¾*describing business and technical issues for decision makers and technical staff, with the business and technical sections each intended to stand alone when used with the overview
- *Case Study Summary*—giving a one-sheet summary intended to stand alone independently from this report
- *Background*—summarizing reasons for pursuing the project
- *Plant Upgrade Options and Expectations*—providing an overview of benefits the project was expected to provide
- *Construction and Startup*—describing TVG's experiences in installing and starting the new plant
- *Results*—showing the impact on the company's bottom line
- *Potential California Applicability*—briefly describing the market potential for other California installations
- *Appendices*—including project participants and a detailed listing of potential California membrane filtration applications

Summary of Business Issues

Project Cost and Financing

The project was completed at a net cost to the company of $7.7 million, after receiving $700,000 in grants from utility and government agencies. TVG funded the project with a State of California economic development bond having a floating interest rate (3.25% in 1999) to be repaid over a 10-year period. TVG considered other options to the membrane system, but all had similar or higher first costs and higher operating costs. Since TVG was committed to keeping the plant open, it pursued the best available option — membrane filtration and zero-discharge operation.

The initial project budget was $7.4 million, which rose to $7.6 million when the final design was completed. Actual project cost was $8.4 million, with the main price increases coming from the ultrafiltration (UF), reverse osmosis (RO), and evaporation equipment, as well as from weather issues and startup problems.

Design and Construction

TVG staff conducted extensive research and testing to identify a viable alternative that met their goals of being environmentally friendly, offering zero-discharge capability, and allowing easy operation. While researching their process flows to design an effective system, TVG staff identified a key opportunity for saving water. Using a process they developed and patented, the project team shortened olive-curing time from seven days to three days, cutting water use by 53% and wastewater flows by 42%.

Construction did not go smoothly, with the project team experiencing delays from both weather and contract negotiations. The combined design and construction process required about the same time as expected—design required longer than expected but construction went faster than expected through constant project management evaluations.

Startup Problems and Solutions

Upon startup, TVG faced a number of hurdles, but worked cooperatively with the contractors and equipment suppliers to achieve proper operation. The main problem was that the membranes were fouling quickly, requiring more frequent cleaning than expected and increasing cleaning costs due to higher chemical, water, and labor requirements. Cleaning chemicals alone initially cost 10 times more than expected. TVG addressed the problem by installing cyclonic air separation systems at point sources to reduce fats, oils, and grease (FOG) and suspended solids.

Projected Versus Actual Operation

In addition to the higher-than-expected cleaning costs, the membrane-filtration plant's energy costs are higher than expected. The actual energy cost is $15.94 per 1000 gallons, 340% higher than expected. Overall, the zero-discharge operation costs 380% more to operate than expected.

Although the membrane filtration system's operating cost is higher than expected, process chemical cost savings from adopting the three-day curing process offset some of the membrane system cost increase so Oberti could produce competitively-priced products. The value of these process-chemical savings is proprietary, so a total operating cost comparison for before-and-after project installation can not be completed.

Table 1 summarizes the membrane filtration system's performance, compared to the initial design and the base-case operation with evaporation ponds.

Table 1: Summary of Membrane Filtration Operations List[1]

Component			*Base Case*	*Membrane Plant*		*Savings (final vs. base)*
				Initial Design	*Final Operation*	
Energy	$0.08/kWh $0.25/therm	$/yr	629,458	977,902	1,262,082	-101%
Maintenance[2]	Membrane system	$million/yr	0.0	0.7	0.7	na

[1] Data for a 20,000-ton production run (one "unit"), the total for approximately one year.

[2] Costs for membrane replacement and pump wear.

Although TVG experienced high operating costs with the membrane-filtration system, other organizations using these units may see lower cost premiums if they use municipal systems for water supply and wastewater discharge. A lower cost premium will result if the municipal

systems charge higher costs than the organization faces by operating its own water supply and discharge systems.

A related consideration for municipal water users is the source-energy[1] impact. Some water districts charge high prices to cover pumping costs. Many California municipalities receive water that has been pumped across great distances, in some cases hundreds of miles and over the Tehachapi Mountains, greatly increasing the cost of the water.

Future Considerations

For companies considering membrane filtration systems on wastewater streams, TVG cautions users to carefully evaluate their process flows to thoroughly understand how to best design a new system. Such process research may also yield process improvements and point-source waste reductions, such as TVG identified. TVG researchers also used a demonstration trailer supported by the State of California and others—this trailer is available for other users as well, to help identify the proper membrane filtration technology for their application. Another key issue is that TVG coordinated their efforts with the Regional Water Quality Control Board (RWQCB) to ensure that the plant satisfied environmental performance expectations, even amid project delays. Other important lessons include:

- Understand that membrane filtration installations in wastewater treatment applications are more difficult to design, install, operate, and maintain than for other process flows.
- Develop good working relationships with potential equipment vendors before starting a project.
- Consider having a small decision-making group constantly involved in the project, as a small group works more efficiently and helps cut costs.
- Investigate new technologies. As a result of the lessons learned at the Oberti Olive plant, manufacturers are taking steps to reduce the costs of membrane replacement, cleaning, and energy use.
- Understand that each membrane filtration installation in each manufacturing process is unique and requires a site-specific design.
- Treat waste sources upstream in the process rather than at the plant outlet.

The Bottom Line

The membrane filtration system allowed the Oberti Olive Plant to remain open while providing an environmentally sound solution to a costly problem. Although startup problems were greater than expected, TVG's dedication and cooperative problem-solving approach resulted in a successful project.

[1] *Source energy* is the energy used to create, and in some cases, to deliver a product (e.g. electricity, chemicals, and natural gas).

Summary of Technical Issues

Membrane Filtration Plant Characteristics

TVG developed the membrane filtration project to produce black ripe olives while recycling all water, chemicals, and olive pomace or converting them to a useful byproduct with no adverse environmental impact. **Figure 5** gives the wastewater processing overview.

The UF and RO systems filter the salts, sugars, remaining oil, and other solids, allowing only water to pass through. These units reclaim approximately 80% of the 700,000 gallons per day (gpd) of wastewater produced. The remaining 20% of the wastewater flow contains solids that are concentrated into an animal feed slurry, using an evaporator rated to remove approximately 60,000 lb/hr of water (7200 gal/hr).

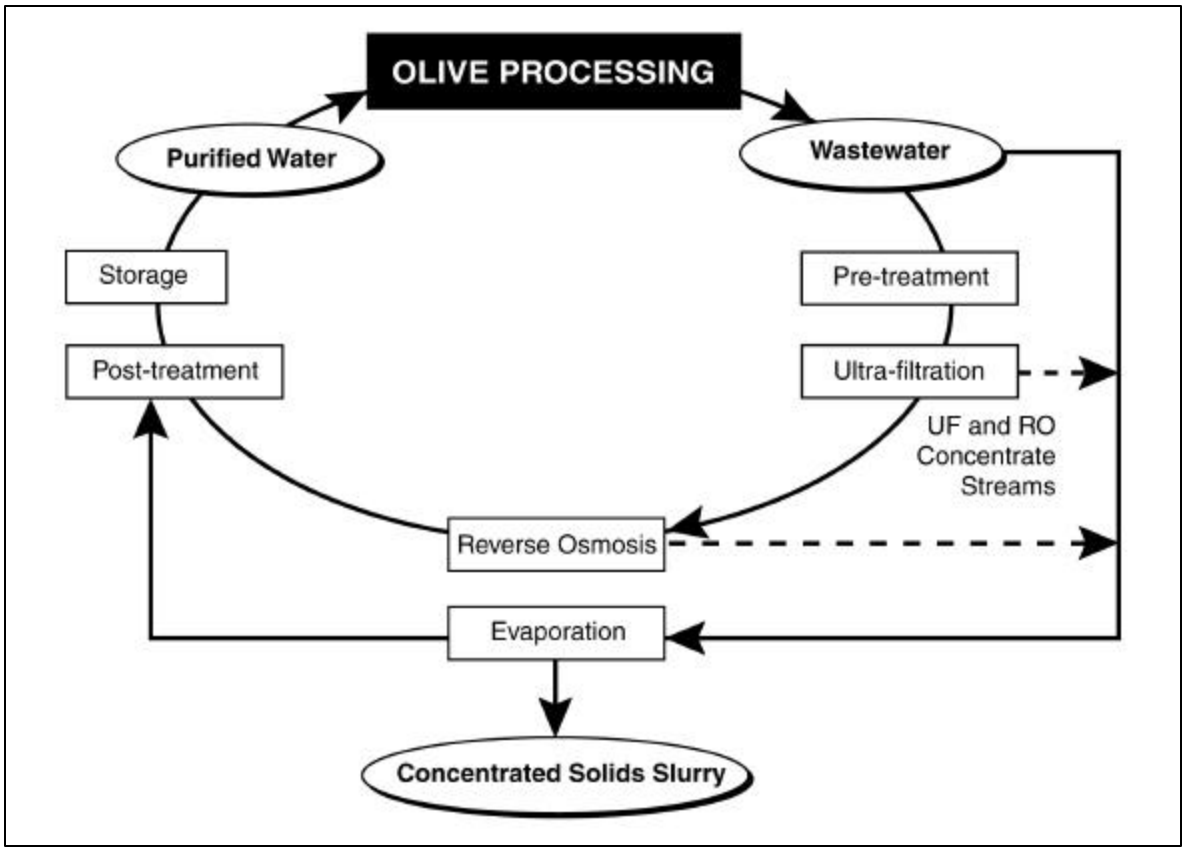

Figure 2: Wastewater Processing Overview

Variable frequency drives (VFDs) modulate flows through all the UF loop pumps and the high-pressure RO pumps to maintain constant loop pressure. The RO pump motors have a "soft start" feature to reduce electric demand charges and protect system elements, especially the membranes, from excessive pressure shock. Table 2 summarizes the membrane-filtration system performance.

Table 2: Membrane Filtration System Performance[1]

Performance Characteristics			*Base Case*	*Membrane Plant*		*Savings (final vs. base)*
				Initial Design	*Final Operation*	
Energy Use						
Fuel	Process steam	Therms/yr	876,780	1,367,000	1,921,410	-119%
Electricity	Plant use	kWh/yr	4,977,810	7,942,857	9,757,334	-96%
	Well-water pumping	kWh/yr	150,476	9,048	14,286	91%
	Total	kWh/yr	5,128,286	7,951,905	9,771,620	-91%
Water Flows	Well-water	mgd	1.3	0.1	0.1	92%
	Wastewater	mgd	1.2	0.0	0.0	100%

[1] Data for a 20,000-ton production run, the total for approximately one year.

Startup and Operation Issues

Plant "startup" was nearly an ongoing process for about two years after the plant became operational in April 1997. The entire first year of operation was very difficult. TVG worked closely with the contractors and equipment vendors to cooperatively develop countless solutions. The following paragraphs describe the primary startup issues.

Oil Contamination: During preliminary startup testing, the system's FOG contamination level was not typical for normal plant operation and the olive crop had lower-than-normal oil content. Thus, the proper startup operation gave plant staff false impressions. This oversight of FOG contamination would become the most severe problem in the design. TVG installed cyclonic air separation systems to address the issue.

High Operating Costs: Membrane cleaning issues plagued plant operators for nearly two years. The cyclonic air separation systems addressed major problems, but plant operators took numerous other steps to fine-tune plant operations and reduce cleaning costs. Even with all the changes, membrane filter cleaning costs and energy cost are higher than expected, as shown below:

- Chemical costs for cleaning filter membranes are about 400% higher than expected—$1,600/day—with system cleaning costs 10 times more than expected.
- Related clean-up water usage is 300% higher than expected, at 150,000 gpd.
- Energy costs for pumping are 340% higher than expected, at $15.94 per 1000 gallons of water.

Table 3 lists the chemical costs associated with membrane system cleaning.

Table 3: Filtration Chemical Cost Comparison

Component	*Actual Operation ($/yr)*
Membrane filtration	255,000
Evaporator	51,000
Carbon filters	59,000
ZPM separation units	56,000
Ozonation	30,000
Total	*451,000*

UF/RO Controls: During the September 1997 startup, plant operators learned that the flow meters on the UF and RO subsystems were inaccurate, causing flow control problems. They addressed the problem with new meters.

Evaporator Capacity: TVG identified water-reduction opportunities during the design phase, primarily from the three-day curing process. However, they did not reduce the plant capacity because of ordering constraints and the possibility that the three-day process would not produce a high-quality product. During startup, plant operators learned that the filters did not perform as designed, but the excess evaporator capacity allowed the system to operate properly after TVG staff improved the system controls.

Traces of Organic Compounds: Chlorine dioxide sanitizing was the only means initially installed to ensure that the processed water remained potable when it returned to the plant. However, the RO system experienced a brief, limited failure, giving the olives an "off" flavor detected by a minority of tasters. TVG discovered the phenol compounds that caused the flavor problems and installed ozonation and carbon filtration to prevent any future flavor problems.

Summary

Installing and operating the new membrane filtration plant was a challenging but worthwhile experience for TVG. However, addressing startup issues was more challenging than expected, and the plant now costs more to operate than expected.

2. Case Study Summary

The following page is a one-sheet summary that can be distributed independent of this report. It is designed for widespread distribution to summarize key results from installing membrane filtration systems.

3. Background

History

When the Oberti family first packed olives in 1935, the accepted practice was to use clay-lined evaporation ponds to hold the brine and evaporate the liquid with solar energy. Over the years, the plant added evaporation ponds as needed to handle production expansion needs. Eventually, however, the clay's porous characteristics allowed slow seepage into the groundwater.

Tri Valley Growers, a grower-owned cooperative, acquired the privately-held Oberti Olive plant in 1968. Soon after, in 1969, new Regional Water Quality Control Board (RWQCB) regulations forced TVG to line its 160 acres of evaporation ponds with a single layer of plastic to eliminate brine seepage. TVG completed this project in 1979 at a cost of $11 million.

Plant Characteristics and Operation

Oberti Olive Division of TVG employs about 75 full-time staff and 500 seasonal workers in a plant with capacity of 20,000 tons per year of black ripe olives. Figure 3 shows the engineering manager and plant manager at the plant entrance.

Figure 3: Oberti Olive Plant Entrance

Roughly 360 million cans are shipped each year. A secondary product is olive oil, with about 40,000–80,000 gallons shipped annually in 55-gallon drums for use by industrial food processors. The plant is one of three remaining olive plants in the United States, all of which are in California. Oberti processes about 21% of California's olives.

Olive processing involves a three-step process—receiving, curing, and canning. In Step One the crop is cleaned, olive stems are removed, the olives are separated by size and then stored in

over 1000 tanks, each capable of storing 25 tons, as shown in Figure 4. Stems are sold to a bio-waste burner. This step coincides with olive harvesting season in the fall and lasts about eight weeks.

Figure 4: Olive Storage Tanks

In Step Two raw olives are processed in a caustic solution. At one time this curing process required 20 days, but over the years Oberti reduced it to seven days. While investigating process flows associated with evaluating options to double-lining the evaporation ponds, TVG staff developed a patented three-day curing process which dropped water requirements from 9600 gallons/ton of olives to 4500 gallons/ton.

In Step Three the olives are pitted, sliced, and canned. Olive pits are processed to recover saleable olive oil and processed pits are sold to a bio-waste burner. The Oberti plant requires about 9 months to process the annual crop.

Fresh water is pumped from private wells, with base-case operation requiring about 1.3 million gallons per day (mgd). Plant requirements dropped to about 0.8 mgd after Oberti implemented the three-day curing process.

Brine resulting from olive storage and the caustic solution from olive processing were historically pumped to a series of nearby evaporation ponds. This brine's salt concentration is approximately two times higher than ocean water.

Table 4 summarizes plant operating characteristics of the base-case plant operation before installing the membrane filtration system.

Table 4: Base-Case Plant Operation

Performance Characteristics			*Base Case*
Energy Use			
Fuel	Process steam	Therms/yr	876,780
Electricity	Plant use	kWh/yr	4,977,810
	Well-water pumping	kWh/yr	150,476
	Total	kWh/yr	5,128,286
Energy Cost	$0.08/kWh; $0.25/therm	$/yr	629,458
Water Flows	Well-water	mgd	1.3
	Wastewater	mgd	1.2

Wastewater Processing Changes Required

In 1984 new RWQCB regulations required Oberti to upgrade its evaporation ponds by 1989 with a double plastic lining to eliminate seepage and to install a leachate collection system. However, the upgrade's projected cost was an unacceptable $40 million, not even including the expense to acquire an additional 160 acres for temporary brine storage.

Stricter environmental regulations have closed other California olive processing plants, the latest being Lindsay Olives in 1992. However, TVG decided to investigate other options because closing the plant would be a devastating blow to the olive growers, many of whom are TVG shareholders.

4. Plant Upgrade Options and Expectations

Initial Concepts Investigated

During the initial stages of finding an option to double-lining the evaporation ponds, TVG staff tested several biological treatment systems, including fermenters and a bio-trickling filter.

One initial concept looked promising, using a bio-digester to convert the wastes to yeast that could be harvested and sold as low-quality animal feed. Nanofiltration (NF), UF, RO, and spray drying were all components of the waste-processing system. Salts would be recovered from the water and sold as a dry animal supplement. The process would discharge the highly-filtered water to either the City of Madera municipal wastewater system or to a local irrigation ditch.

However, project staff feared future regulations would limit discharging water to the municipality. Further, local politics would not allow discharge to an irrigation ditch. Finally, the system design was very complex and costly and the digester required continuous operation 24 hours/day, 7 days/week, which would have been difficult to achieve. This option was abandoned after spending $3.5 million.

After re-evaluating the situation, TVG identified three goals for the new wastewater treatment system:

1. Environmentally friendly
2. Zero discharge outside the plant
3. Easy to operate.

Additionally, any products leaving the plant would have beneficial uses and the wastewater treatment plant would not be the controlling force in producing olives.

TVG aggressively decided on the zero-discharge option to avoid any more new regulations that could again put olive processing in jeopardy.

RWQCB Negotiations Yield Revised Schedule

While identifying and evaluating alternatives to double-lining the evaporation ponds, TVG maintained close communication with the RWQCB to ensure that their plans were acceptable. In turn, the RWQCB exhibited flexibility with their timelines. For example, with realistic solutions apparently within reach, in August 1991 the RWQCB issued an order that TVG cease discharging to evaporation ponds by December 31, 1993 and close the ponds by December 31, 1995. As TVG encountered trouble implementing a feasible design, the RWQCB relaxed its shutdown schedule.

Additional Research Identifies Process Improvement

To achieve their objectives, TVG began an extensive evaluation of its processes, waste streams, and potential technologies in 1991. Staff performed chemical analyses on effluents, identified how and where the materials entered the waste streams, and evaluated technologies that were familiar from other plants. This process research resulted in developing a patented process change to shorten curing time from seven days to three days, cutting water use by 53%, to 4500 gallons/ton, with a similar reduction in wastewater flow.[2]

Membrane Technology Option Determined

The research on process flows led TVG to pursue a combination of membrane filtration and evaporation for filtering and concentrating the brine solution. Membrane filtration has been used commercially since the early 1980s to separate whey in the dairy industry, clarify juices in the beverage industry, reclaim sugars and other recyclable products from waste streams, and desalinate small amounts of seawater. Types of membrane filtration include reverse osmosis (RO), nanofiltration (NF), ultrafiltration (UF), and microfiltration (MF), in order—from small to large—of the particle size that each system treats.

Membrane filtration technologies were familiar to TVG staff from their experience with juice concentrate at fruit processing plants, and from their experience with water used to clean cans at tomato processing plants. However, TVG learned that a wastewater stream's components require a different design and operation than a membrane filtration system applied to non-waste streams. The zero-discharge characteristic is an additional complication.

TVG worked together with the California Institute of Food and Agricultural Research (CIFAR) at the University of California Davis, Pacific Gas and Electric (PG&E), the Electric Power Research Institute (EPRI), the RWQCB, and many other sponsors to develop a solution tailored to Oberti's needs. In 1992 Oberti became the first California food-processing plant to test CIFAR's mobile membrane filtration demonstration unit, a 48-foot trailer built to test various systems.

After 13 in-plant demonstrations, together with CIFAR's and EPRI's membrane technology experience, researchers recommended the specific UF and RO membrane types and characteristics, from among the dozens available, that would deliver potable water for process applications.

TVG then developed a design based on membrane filtration that met the initial project requirements. The design process included developing a mathematical model to test the design in real time and to discover how process variations would affect operation of a zero-discharge plant. Table 5 below summarizes characteristics of the options TVG considered.

Table 5: Characteristics of Plant Options

[2] TVG implemented the three-day curing process in 1995, while the membrane filtration plant startup was in 1997.

Option	*Relative Capital Cost*	*Relative Operating Cost*	*Comments*
Primary Options			
Membrane filtration with evaporation	1.0	1.0	Lowest capital cost. Relatively simple operation. Adopted.
Biotower with filtration, evaporation, and drying	2.0	2.0	High capital and operating costs. Complex operation. Abandoned.
Double-lined ponds	5.3	0.0	Not environmentally sound. Capital cost not acceptable.
Secondary Options			
Ceramic Membrane/Evaporation	1.6	3.1	High capital cost. High operating cost.
Evaporation/Polish Filtration	2.1	1.1	High capital cost. Low operating cost

Zero-Discharge Plant Design Overview

TVG developed the membrane filtration project to produce black ripe olives while all water, chemicals, and olive pomace were recycled or converted to a useful byproduct with no adverse environmental impact.

TVG's research into plant operations and olive processing identified six waste streams that would be handled by the new membrane system:

1. Olive oil processing water
2. Cannery processing water
3. Low-to-neutral pH vatroom processing waters
4. High pH vatroom processing waters
5. Olive storage water
6. Storm water runoff

A brief description of the zero-discharge design follows. See also the wastewater processing overview in **Figure 5** and the wastewater plant schematic in Figure 6.

Olive wastewater from the brine storage tanks and the oil mill is prescreened and pumped directly to the evaporator. Wastewater from the vat room (i.e., olive curing area) and cannery are pre-screened and pumped to a one-million-gallon effluent storage tank.

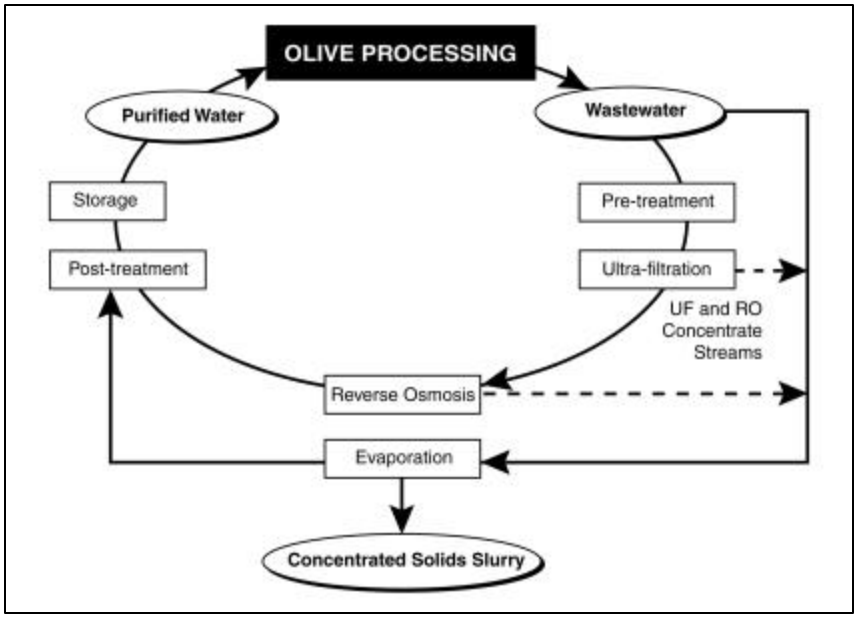

Figure 5: Wastewater Processing Overview

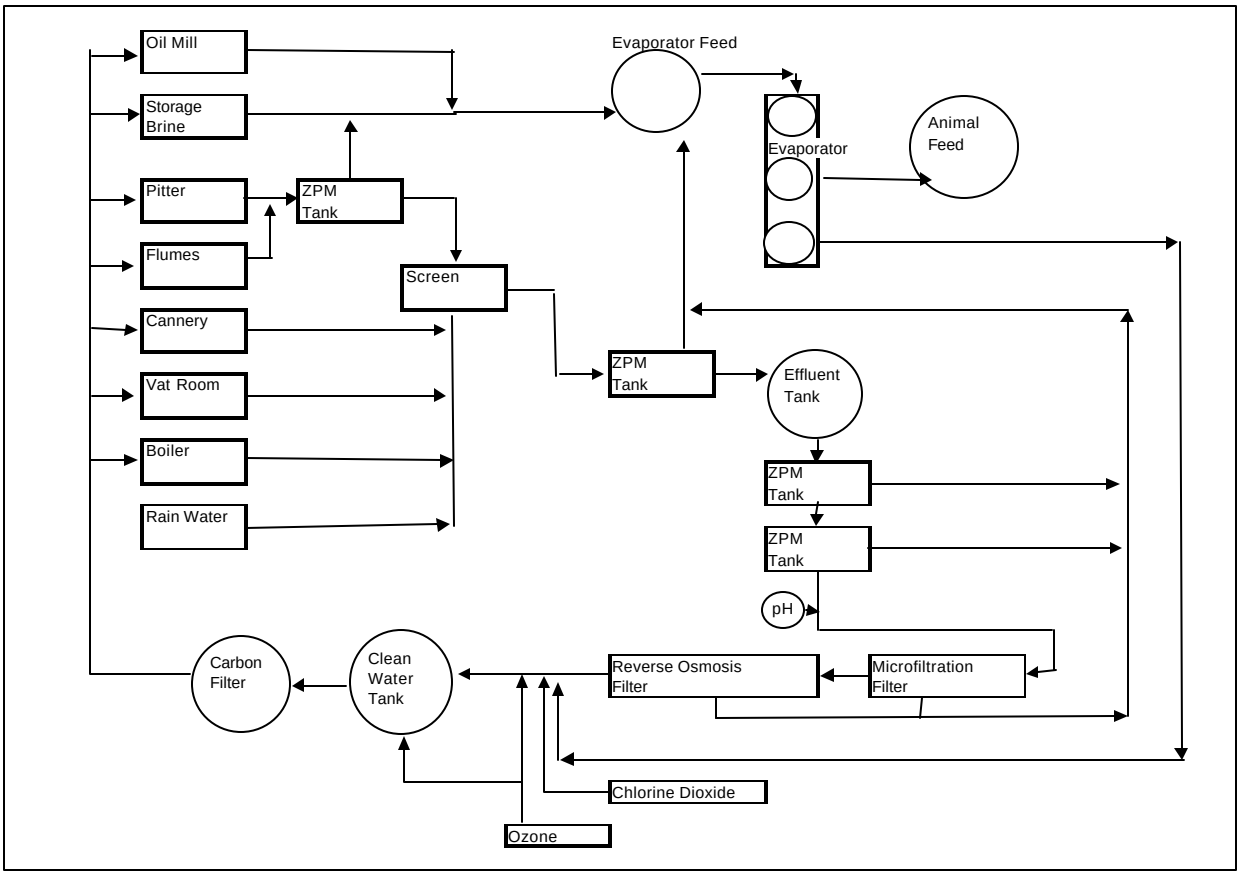

Figure 6: Wastewater Plant Schematic

From the collection sump, shown in Figure 7, the effluent is pumped to the UF system, which filters the salts, sugars, remaining oil, and other solids, allowing only water to pass through. Retentate, or concentrate, from the UF system flows to the evaporator. Permeate (containing salts and other dissolved components) from the UF is piped to the RO system. Retentate from the RO joins the UF retentate, both of which enter the evaporator. The UF system was designed for a maximum flow of 750 gpm and a maximum daily flow of 900,000 gallons, although the maximum operational flow has never exceeded 650 gpm. The UF and RO units were designed to operate at concentration ratios of 20X and 10X, respectively.

Figure 7: Vatroom Collection Sump

The evaporator—a triple-effect, falling-film unit—removes up to 60,000 lbs./hour (7200 gallons/hour) of water at a thermal efficiency of 4.5:1. This unit increases the slurry concentration from 1.5% to 60% solids. The resulting concentrated slurry is stored in a tank until it is hauled to Foster Farms, an animal feed manufacturer.

Condensate from the evaporator is pumped to a one-million-gallon permeate storage tank. Permeate from the RO membranes is also piped to this tank. Following chlorination and ozonation, this purified water is pumped back to the plant for use in the cannery, vat room, and oil mill.

The UF and RO systems reclaim approximately 80% of the 700,000 gallons per day (gpd) of wastewater produced. The remaining 20% is evaporated into an animal feed slurry. Variable frequency drives (VFDs) modulate flows through all the UF loop pumps and the high-pressure RO pumps to maintain constant loop pressure. The VFDs also reduce operating costs compared to throttling valves, the traditional method of providing flow and/or pressure control.

The RO pump motors have a "soft start" feature to reduce electric demand charges and protect system elements, especially the membranes, from excessive pressure shock. The starting ramp is 30 seconds, providing a smooth pressure rise.

Expected Performance

As shown in Table 6, the proposed membrane filtration system eliminated wastewater discharge, but at an increased energy cost of 55%. The increased energy consumption resulted from having to pump wastewater through the membrane filter bank and from operating the steam-fired evaporator. Although energy costs increased, chemical savings from implementing the three-day olive-curing process offset the increased energy costs to make the project financially viable.

Table 6: Expected Membrane Filtration System Performance

Performance Characteristics			*Base Case*	*Membrane*	*Savings*
Energy Use					
Fuel	Process steam	Therms/yr	876,780	1,367,000	-56%
Electricity	Plant use	kWh/yr	4,977,810	7,942,857	-60%
	Well-water pumping	kWh/yr	150,476	9,048	94%
	Total	kWh/yr	5,128,286	7,951,905	-55%
Energy Cost	$0.08/kWh; $0.25/therm	$/yr	629,458	977,902	-55%
Water Flows	Well-water	mgd	1.3	0.1	92%
	Wastewater	mgd	1.2	0.0	100%
Maintenance	Membrane system	$/yr	$0	$0.7 million	-$0.7 million

From a perspective of overall societal benefit, the project was expected to increase source-energy[3] use by 48% and increase air emissions proportionally. However, as a additional benefit, olive pumace (pits, etc.) was expected to be sold to a cogeneration facility. The energy value of the pumace was expected to cut source energy, cutting the project's overall source-energy impact by 14%.

Budget, Investment Criteria, and Funding

The project's initial $7.4 million budget grew to $7.6 million by the time that the final design was completed. Table 7 shows the initial and final budgets. TVG's net cost was reduced by $0.7 million because a number of partners contributed funding, as shown in Table 8.

[3] The analysis assumes 10,500 Btu of source energy per kWh of electricity and 11,600 Btu of source energy per $1 of chemicals.

Table 7: Project Design Budget Comparison

Component	*Initial Design Budget*	*Final Design Budget*
Ultrafiltration and Reverse Osmosis	1,900,000	2,300,000
Evaporation	1,900,000	2,200,000
Dryer	700,000	0
Buildings	25,000	120,000
Electrical, Controls	500,000	500,000
Automated UF and RO Data Collection	400,000	300,000
Tanks and Piping	600,000	1,200,000
Storm Water Collection	800,000	300,000
Contingency	600,000	680,000
Total Project Cost	*7,425,000*	*7,600,000*

TVG's return on investment (ROI) analysis showed that the plant, as designed, would produce a product at a competitive price. A critical component, integral to the project's success, was the three-day curing process cutting chemical costs enough to offset the increased energy and maintenance costs. TVG selected the membrane filtration option as the only reasonably-priced, viable alternative with a favorable ROI.

TVG worked with the Madera County Economic Development Commission to obtain a state bond and fund the project. The bond was first approved by the county on October 24, 1995, with the State of California Treasury Department approval coming shortly thereafter. The bond has a floating interest rate (3.25% in 1999), payable over 10 years.

The bond was a critical element in the project's success. Without it TVG may not have been able to fund the project and the plant likely would have closed.

Project Partners

With such high project costs and obvious environmental benefits, TVG sought funding assistance from organizations supporting such projects, including the local electric and gas utility. Three organizations contributed grants and rebates totaling $700,000, as shown in Table 8.

Table 8: Project Funding Partners

$400,000	U.S. Department of Energy's (DOE) NICE^3 program (National Industrial Competitiveness through Energy, Environment, and Economics)
$250,000	California Defense Conversion Council
$100,000	Pacific Gas and Electric Company
$700,000	*Total*

DOE's NICE^3 program, administered through the California Energy Commission (CEC), helps promote the installation of advanced, energy saving industrial technologies.

Expected Timeline

The timeline that was originally scheduled for the project is summarized in Table 9.

Table 9: Expected Project Timeline

DOE NICE^3 grant application	January 1995
State bond approved	October 1995
Design commercial plant and select equipment	June 1995
Begin construction	July 1995
Finalize design	September 1995
Complete construction	July 1996
Startup and shakedown	September 1996
Unit fully operational	December 1996

5. Construction and Startup

Overview

In general, design and construction went well but plant startup was very difficult, greatly delaying smooth operation. Additionally, operating and maintenance costs, particularly membrane cleaning and replacement, were much higher than expected. However, plant personnel solved countless problems and achieved zero-discharge operation.

Design, Construction and Budget Issues

The design process and construction went smoothly, though diligent project management and continuous interaction of the design team, equipment vendors, and contractors. The design team conducted three years of testing to define the scope and process, steps completed prior to construction. The project team used a design-build approach to implement the project and TVG did not experience any major changes during construction. Major design considerations included:

- Reducing water and chemical usage by applying a three-day curing process
- Pre-screening all waste streams
- Using a tank farm to maintain balanced water flows
- Applying UF and RO filters to remove organics and salts
- Using an evaporator to concentrate waste streams coming from the filter banks
- Sending the evaporator-concentrate to a pre-selected animal feed supplier

A key issue was finding a use for the sludge remaining after the wastewater passes through the membrane filtration bank and is concentrated in the evaporator. TVG identified Foster Farms, a manufacturer of animal feed, as an outlet for this byproduct. On a related note, the concentration of all chemicals and additives in the waste sludge (i.e., animal feed) must be acceptable as animal feed.

Similarly, everything that falls on the facility grounds (e.g., engine oil drips) must be contained because rainwater effectively washes everything into the main holding tank where it eventually ends up in the waste sludge (i.e., animal feed).

The project cost grew from the $7.4 million initial design estimate to a final installed cost of $8.4 million because of weather issues, problems encountered after startup, and equipment cost increases, primarily UF, RO, and evaporation units.

Startup Issues

Plant "startup" was an ongoing process for two years after the plant became operational in April 1997. Only two weeks of testing were conducted during this initial startup because no more fruit was available. No problems were encountered during this preliminary testing.

The filtration unit went on-line with no discharge to the evaporation ponds in September 1997. After just a few days of operation a number problems began to appear. The major problems included:

- Lack of automatic evaporator operation
- Failed filtration controls
- Excessive FOG contamination
- High filtration cleaning cost
- Off-flavor product taste

The following sections describe the primary startup issues.

Oil Contamination

Plant operators conducted preliminary startup testing during a two-week period in early May 1997. They operated only one-half of the membrane filtration system to preserve the other half in case the system failed.

Although the plant experienced no major problems, TVG and the equipment vendors did not realize the filtration system and re-circulated water flows did not reach equilibrium. In fact, since the plant was near the end of its annual processing cycle, the olive oil mill was not operating and the newly installed oil separators did not have a normal level of dirt and contaminants. Further, the 1996 olive crop, which Oberti was processing during the May 1997 pilot testing, had lower-than-normal oil content.

Thus the system's FOG (fats, oils, and grease) contamination level was not typical for normal plant operation and the proper May 1997 startup gave plant personnel false impressions. This oversight of excessive FOG contamination would become the most severe problem in the design.

TVG first installed multi-chamber gravity separators but they were not effective. Eventually TVG alleviated the FOG issue by fitting the five major waste streams with proprietary cyclonic air separation systems developed by ZPM, as shown in Figure 8. These systems removed FOG and suspended solids. The oily concentrate from the ZPM units is fed directly into the evaporator feed tank.

Although the ZPM units greatly improved plant performance, the UF and RO units operate at only 15X and 6X concentration ratios, respectively, below the design levels of 20X and 10X.

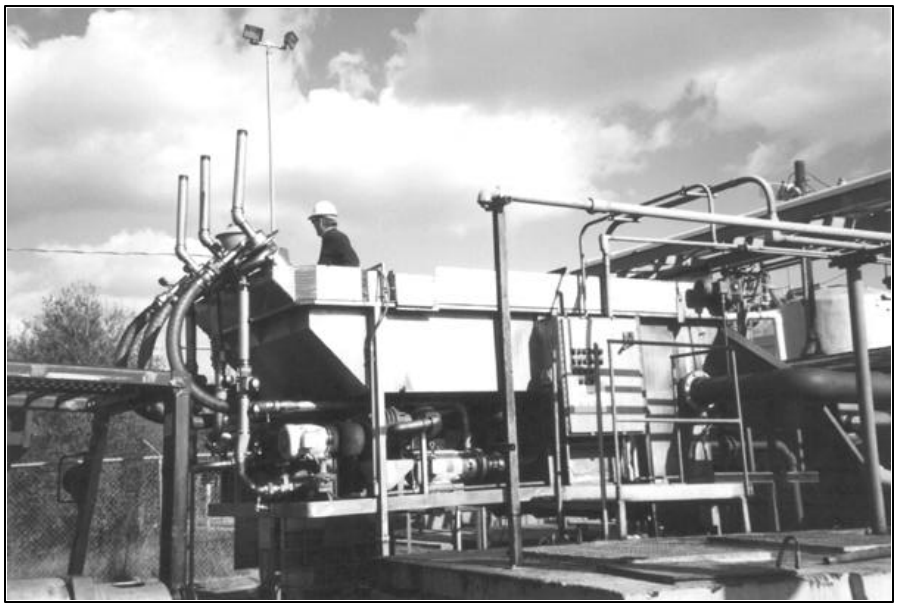

Figure 8: Cyclonic Air Separation System

Evaporator Controls

During the September 1997 startup for processing the new crop, plant operators learned that the evaporator would not operate automatically as it was designed. TVG and Oberti staff redesigned the evaporator control system to operate automatically, but their initial design exceeded the evaporator's range and design capacity. Redesigning this control scheme required nearly four months to perfect and implement. Plant operators ran the evaporator in manual mode until the new controls operated properly.

In a related issue, TVG identified water-reduction opportunities during the design phase, primarily from the three-day curing process. However, they did not reduce the plant capacity because of ordering constraints and the possibility that the three-day process would not produce a high-quality product. During startup plant operators learned that not only did the filters not perform automatically as designed, but the unit did not deliver the promised concentration levels. However, the excess evaporator capacity allowed the system to operate properly after TVG staff improved the system controls.

Filtration Problems

During the September 1997 startup for processing the new crop, plant operators learned that the flow meters on the UF and RO subsystems were inaccurate. Failure to identify the flow error during the May 1997 startup resulted in a 50% error in flow measurements and concentration ratios. Repairing and ultimately replacing the flow meters only identified further problems, such as excessive clean-up water requirements, high cleaning-chemical use, and membrane failures. TVG staff addressed these issues with a series of improvements during the two-year startup.

Operation and Maintenance Issues

As noted earlier, plant personnel considered startup as a two-year process. For this analysis, the following items are classified as operation and maintenance issues since they occurred quite a few months after the membrane filtration plant began operation, even though they could be considered start up issues.

Filter Cleaning

As noted above, membrane cleaning issues were first identified during startup. However, they plagued plant operators for nearly two years. High FOG contamination increased membrane filter cleaning chemical costs about 400% above expected levels, to $1,600/day. Similarly, energy costs rose 340% above expected levels, from $4.69 to $15.94 per 1000 gallons of water. Related cleaning-water usage increased 300% as well, from 50,000 gallons/day to 150,000 gallons/day. The proprietary cyclonic air separation systems addressed major problems, but plant operators took numerous other steps to fine-tune plant operations and reduce cleaning costs.

Traces of Organic Compounds

Chlorine dioxide was the only sanitizing agent initially installed to ensure that the filtered water remains potable when it returns to the plant. However, the RO system experienced a brief, limited failure, allowing some impurities to contaminate the purified water. This failure resulted in olives with an off-flavor that about 20% of the population could detect. After extensive investigation TVG discovered the phenol compound, in the range of 1 to 10 parts-per-billion, causing the flavor problems. Although TVG repaired the RO problem, it also installed ozonation and carbon filtration to prevent any future flavor problems.

Miscellaneous

Plant operators identified other operating issues, including:

- Prescreens must be properly sized to prevent excessive fouling of UF membranes
- UF membranes have an optimal cleaning-in-place frequency to maximize their performance and life expectancy
- A monitoring system is important to allow immediate detection and warning of a membrane failure

The project team designed and installed a sophisticated energy-monitoring hardware and software intended to track the filtration system's performance. However the equipment manufacturer never completed development of drivers for the computer interface and only limited manual monitoring was available.

Pond Closure Issue

TVG must still clean up the evaporation ponds, although they are no longer in use. Solar evaporation is too time-consuming so TVG has hired a specialist to evaluate options. One

alternative may be to use the existing evaporator to concentrate the water and to dispose of the concentrate as an animal supplement.

Timeline

After deciding to move ahead with the project, TVG was delayed with contract negotiations and by rainy weather. Additionally, as noted above, extensive startup problems delayed stable plant operation until 1999. Table 10 compares the actual timeline with the projected dates.

Table 10: Actual Project Timeline

Activity	*Projected Date*	*Actual Date*
Design commercial plant and select equipment	June 1995	December 1995
Finalize design	September 1995	December 1996
Begin construction	July 1995	January 1997
Complete construction	July 1996	April 1997
Startup and shakedown	September 1996	April 1997
Unit fully operational	December 1996	September 1997
Stable, acceptable operation	December 1996	June 1999

6. Results

Summary

The membrane filtration system, shown in Figure 9 and Figure 10, allowed the Oberti Olive plant to remain open. Although plant startup was very difficult, TVG would make the same decision again to install the new system.

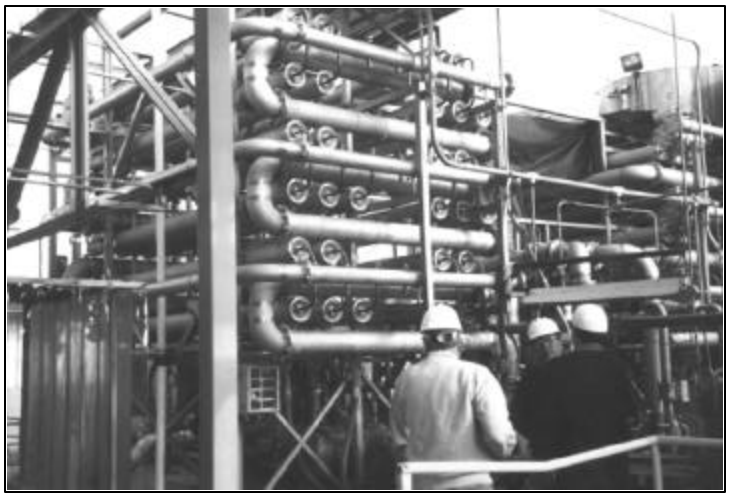

Figure 9: Membrane Filtration Bank

Figure 10: Membrane Filtration Bank and Evaporator

Although the membrane filtration system has been successful, changing business conditions forced the plant to curtail canning operations. In late 1999 plant management identified frozen-food markets not requiring a canned product, allowing Oberti to shut down the membrane filtration plant and use only the evaporator to process wastewater.

The Bottom Line

The membrane filtration installation delivered the key benefit TVG expected to achieve—zero discharge operation while not using the evaporation ponds.

Another critical benefit is that the three-day olive-curing process greatly reduced the chemical costs for olive processing, offsetting energy cost increases. The value of these process-chemical savings is proprietary, so a total operating cost comparison for before-and-after project installation can not be completed.

A summary of operational characteristics is listed below and in summarized in Table 11.

- The plant remains open, saving 575 jobs.
- Zero wastewater is discharged to evaporation ponds.
- Energy costs are 101% higher than base-case (i.e., evaporation pond) operation and 29% higher than expected in the initial design.
- Filtration-system chemical costs are four times higher than expected.
- System-wide chemical cleaning costs are nearly 10 times higher than expected in the final design, as shown in Table 12.

Table 11: Membrane Filtration System Performance[1]

Performance Characteristics			*Base Case*	*Membrane Plant*			*Savings (operation vs. base)*
				Initial Design	*Final Design*	*Final Operation*	
Energy Use							
Fuel	Process steam	Therms/yr	876,780	1,367,000	1,267,940	1,921,410	-119%
Electricity	Plant use	kWh/yr	4,977,810	7,942,857	7,138,953	9,757,334	-96%
	Well-water pumping	kWh/yr	150,476	9,048	13,714	14,286	91%
	Total	kWh/yr	5,128,286	7,951,905	7,152,667	9,771,620	-91%
Energy Cost	$0.08/kWh $0.25/therm	$/yr	629,458	977,902	889,198	1,262,082	-101%
Water Flows	Well-water	mgd	1.3	0.1	0.1	0.1	92%
	Wastewater	mgd	1.2	0.0	0.0	0.0	100%

Performance Characteristics			*Base Case*	*Membrane Plant*			*Savings*
				Initial Design	*Final Design*	*Final Operation*	*(operation vs. base)*
Maintenance[2]	Membrane system	$million/ yr	0	0.7	0.7	0.7	0

[1] Data listed for a 20,000-ton production run (one "unit"), the total for approximately one year.

[2] Costs for membrane replacement and pump wear.

Olive pumace sales to the cogeneration plant have been inconsistent since the nearby plant was closed for a period. With the plant using 51% more gas and 37% more electricity than the final design, the source energy usage and air emissions have increased proportionally. Table 12 compares chemical costs associated with the membrane system. As noted earlier, the system's chemicals cost about ten times more than expected.

Table 12: Zero-Discharge System Chemical Cleaning Cost Comparison

Component	*Initial Design ($/yr)*	*Final Design ($/yr)*	*Actual Operation ($/yr)*
Membrane filtration	0	46,000	255,000
Evaporator	0	2,100	51,000
Carbon filters	0	0	59,000
ZPM separation units	0	0	56,000
Ozonation	0	0	30,000
Total	*0*	*48,000*	*451,000*

Table 13 compares the initial and final budgets, as well as the actual construction cost. The UF and RO equipment contributed the most to the cost increase, although some costs dropped, such as the storm water collection system. In addition to the direct costs listed below, TVG and Oberti technical staff contributed over 40,000 man-hours to the project.

Table 13: Project Budget Comparison

Component	*Initial Budget ($)*	*Final Budget ($)*	*Actual Cost ($)*
Ultrafiltration and Reverse Osmosis	1,900,000	2,300,000	2,200,000
Evaporation	1,900,000	2,200,000	2,400,000
Dryer	700,000	0	0
Buildings	25,000	120,000	80,000
Electrical, Controls	500,000	500,000	600,000
Automate UF,RO Data Collection	400,000	300,000	200,000
Tanks and Piping	600,000	1,200,000	2,800,000
Storm Water Collection	800,000	300,000	70,000
Contingency	600,000	680,000	na

Component	*Initial Budget ($)*	*Final Budget ($)*	*Actual Cost ($)*
Total Project Cost	7,425,000	7,600,000	8,350,000

Changing Business Conditions

Changing business conditions have forced the Oberti Olive plant to cut costs to remain competitive. In late 1999 plant management identified new frozen-food markets not requiring a canned product. This should allow the plant to operate without the membrane filtration unit and its associated high operating costs. Instead, the evaporator can concentrate all of the reduced wastewater flow, with the waste sludge still being shipped to the animal feed supplier. Although the membrane filtration plant will likely not be used, it allowed the plant to remain operational for the last 10 years and plant management applied their knowledge of zero-discharge plant operation to develop a revised process with greatly reduced operating cost to serve the new market.

Suggestions for Future Installations

TVG engineers, research staff, and plant operators have learned many lessons in implementing their zero-discharge membrane filtration system. A number of items were identified earlier in discussions on how TVG addressed various issues. The following are additional suggestions:

Business Issues

- Develop good working relationships with potential equipment vendors before starting a project.
- Consider having a small decision-making group constantly involved in the project to cut costs.
- Constantly evaluate the project as it is being designed and installed.
- To reduce cost from change orders, don't change a part once it has been ordered or construction has started.
- Identify outlets for solid wastes that will not cause long-term environmental problems.
- Implement a skills-testing process to identify appropriate plant operators. TVG's use of the "Skills 2000" operator selection system was very successful. TVG and the equipment supplier compiled a list of operator skills, functions, and operator requirements. An outside firm conducted the testing with the cooperation of the plant bargaining unit.

Process Design Issues

- Understand the plant process, process flows, flow components, and how they relate to each other.
- Be willing to invest extensive efforts in testing alternative designs.
- Reduce process flows if possible before implementing a filtration project.
- Treat waste sources upstream in the process rather than at the plant outlet.
- Test waste streams to confirm compatibility with membranes under consideration.

- Apply programmable logic controllers (PLCs) and man-machine-interface (MMI) to reduce the plant operator's learning curve.

Technology Selection Issues

- Investigate new technologies. As a result of the lessons learned at the Oberti Olive plant manufacturers are taking steps to reduce the costs of membrane replacement, cleaning, and energy use.
- Understand that membrane filtration installations in wastewater treatment applications are more difficult than for other process flows.
- Realize that each membrane filtration installation in each manufacturing process is unique and requires a site-specific design.

Current Market Conditions

To TVG's knowledge, no other zero-discharge plants have been designed using membrane technology. The two other California olive plants currently do not face environmental restrictions to make them interested in achieving a zero-discharge operation.

7. Potential California Applications

Best Applications

As demonstrated at the TVG installation, good candidate sites for applying membrane filtration on wastewater systems are those facing a need to address environmental regulations that are so restrictive they would cause financial hardship. Table 14 summarizes characteristics of good candidate sites for membrane filtration.

Table 14: Characteristics of Candidates for Membrane Filtration

Characteristic	*Observation*
• Needing to upgrade evaporation pond lining	• As TVG discovered, environmental regulations can become more stringent over time, negating previous efforts to remain within compliance.
• Needing to expand evaporation pond capacity	• Implementing a zero-discharge design may be less expensive and faster than acquiring new land and associated permits for new evaporation ponds.
• Facing increased water supply costs	• California's water-supply is getting tighter, with higher flows guaranteed for environmental needs (e.g., salmon spawning) and with a quickly growing population. Eventually water prices will increase, making zero-discharge designs more cost-effective.
• Facing increasing wastewater treatment costs from a municipality.	• Some municipalities penalize industrial plants that contribute heavily to their systems.
• Experiencing high water evaporation costs (e.g., inefficient evaporators or high gas costs)	• Energy savings from reusing rather than evaporating water are more valuable in high energy-cost systems.
• Valuable by-products are lost in wastewater streams.	• Filtration would recover the by-products.

Candidate Companies

Membrane filtration technologies are used by the dairy, chemical, and pulp and paper industries, and other businesses that use large volumes of water for processing and/or want to recover byproducts from their waste streams. The food processing industry is one of California's largest users—over 8,000 plants each use an average of one million gallons per day to wash, cook, and package foods. Many food processors generate and discharge large quantities of wastewater to municipal treatment facilities.

As demonstrated by the TVG installation, food processors can successfully apply membrane filtration technology. Several California food processing plants have successfully applied the technology to reduce wastewater treatment costs, including a Sunkist Growers orange juice processing plant in Tipton and a Del Monte fruit cocktail canning plant in San Jose.

Olive plants are obvious candidates to install membrane filtration systems and apply the lessons learned at TVG. However, the two primary olive plants remaining in California[4] (and the U.S.) do not face comparable environmental restrictions. One continues to use evaporation ponds while the other discharges directly into the Sacramento River.

Researchers have identified tomato processors as intensive water users, making them good candidates for membrane filtration. Peach and pear industries are also potential candidates, as noted by Oberti Olive Division staff.

Information Resources

CIFAR, at UC Davis, is a valuable resource to identify potential California membrane filtration applications and apply the technology. Dr. Jatal Mannapperuma and Dr. Jurgen Strasser from CIFAR were instrumental in qualifying TVG's candidate technologies and are available to consult on future membrane applications.

Further, Jatal Mannapperuma developed two references that describe potential membrane applications in the California food processing industry:

- Membrane Applications in Food Processing, Volume 1: Fruit and Vegetable Processing Industry; The Final Report on the Membrane Application Demonstrations Conducted by the Mobile Test Demonstration Unit at Eight Fruit and Vegetable Processing Plants in California During October 1992–February 1994; CIFAR, UC Davis PIO Report CR-105377-V1.

- Survey of Water Use in the California Food Processing Industry, presented at the 1993 Food Industries Environmental Conference.

A second information source to identify potential membrane applications is the 1997 California Business Register database, which lists all California companies and categorizes them according to business type. Each company listing includes a range of characteristics, including site contacts and sales volume.

[4] "Boutique" olive processors have insignificant production compared to the three major plants.

A database sort to identify potential membrane-filtration sites in California for the 2033 SIC code (canned fruits and specialties) gave some 130 sites. These are listed in Appendix B: Potential Applications at California Food Processing Plants. For each site the following data are included:

- Company name, address, and phone number
- Executive contact and title
- Business description
- Number of employees
- Annual sales

* * *

APPENDICES

Appendix A: Project Participants

Major Vendors

GEA Niro Inc.
Process Technology Division
9165 Rumsey Road
Columbia, MD 21045-1991
Bo Bjarekull

Filtration Systems Division
1600 O'Keefe Road
Hudson, WI 54016
Swami Sinundrum

Desal Desalination Systems Inc
760 Shadowridge Drive
Vista, CA 92083-7986
Fred Liberatore

ECOLAB
Klenzade Food and Beverage Division
8912 E. Pinnacle Peak Road
Suite 625
Scottsdale, AZ 85255
Dennis E. Harman

ZPM
Oil Removal Pre-treatment Equipment
Dwain E. Morse
5770 Thornwood Drive
Santa Barbara, CA 93177

Matheny Industrial Builders
General Contractor
PO Box 549
Ceres, CA 95307
Ira Matheny

Foster Commodities
Animal Feed
1900 Kern Street
Kingsburg, CA 93631
Don Jones

Consulting and Design

Complere Engineering
Structural Design and Drawings
4230 Kiernan Ave
Modesto, CA 95356-9323
Dennis Thorpe

EPRI (Electric Power Research Institute)
Design Concepts and Energy Analysis
3412 Hillview Avenue
Palo Alto, CA 94303
K. R. Amarath

CIFAR California Institute of Food and Agricultural Research
Design Confirmation
258 Cruess Hall
Davis, CA 95616
Sharon P. Shoemaker Ph.D.

Harding Lawson & Associates
Pond Closure Hydrology
10265 Rockingham Dr, Suite 150
Sacramento, CA 95827
Michael Leacox

Grants

PG&E
444 Market St
PO Box 770000
San Francisco, CA 95814
Jon Livingston

DOE NICE^3
California Energy Commission
Industrial Process Energy
1516 Ninth Street
Sacramento, CA 95814
Clinton Lowell, Jr.

California Trade and Commerce
Office of Strategic Technology
200 E. Del Mar Ste. 204
Pasadena, CA 91105
Gene Moscrat

Tri Valley Growers

Jeff Shaw	CEO
Richard Claiborn	CFO
Fred Baker	Group VP Agriculture & Operations
Dave Wissing	Manager of Operations Services
* Mike Bodine	Manager, Mechanical Engineering (Project Manager)
* Don Jepson Ph.D.	Manager, Process Engineering
* Bob Moore	Plant Manager, Oberti Olive Division
Carl Beckwith	Manager of Electrical Engineering
Steve Smialkowski	Manager of Control Engineering
Jon Satterfield	Project Engineer
Herb Kangas	Field Engineer

* Design team for final design and construction. This team approved all design concepts, construction, and modifications.

Appendix B: Potential Applications at California Food Processing Plants

Agrigold Juice Products
PO Box 1630
Corona, CA 91718-1630
Phone: 909-272-2600
Reid Neu, Partner
Processes fresh and frozen citrus juices
Sales Range: $5 to $9.99 Million

American Home Food Products Inc
500 Crocker Dr
Vacaville, CA 95688-9245
Phone: 707-448-8411
Manufactures processed foods and tomato paste
Sales Range: $1 to $4.99 Million

Artichoke Industries Inc
PO Box 1307
Castroville, CA 95012-1307
Phone: 408-633-2423
Valerie Woerner, President
Manufactures canned artichokes, brussels sprouts, mushrooms and asparagus
Sales Range: $5 to $9.99 Million

Asian Condiments & Spices Ltd
14455 Don Julian Rd
La Puente, CA 91746-3102
Phone: 818-336-3886
David Lee, President
Manufactures canned fruits and vegetables
Sales Range: $10 to $24.9 Million

Atwater Canning Co
PO Box 814
Atwater, CA 95301
Phone: 209-358-5616
Cans beans and tomatoes
Sales Range: $5 to $9.99 Million

Bell Carter Foods Inc
3742 Mount Diablo Blvd
Lafayette, CA 94549-3606
Phone: 510-284-5933
Jud Carter, President
Ripe olive canning
Sales Range: $1 to $4.99 Million

Bell Flavors & Fragrances Inc
PO Box 867
Larkspur, CA 94977-0867
Phone: 415-924-5818
Manufactures aromatic chemicals, concentrated fruit juices and essences
Sales Range: $10 to $24.9 Million

Bell-Carter Olive Co
1012 2nd St
Corning, CA 96021-3248
Phone: 916-824-2901
Jud Carter, President
Olive cannery
Sales Range: $50 to $99.9 Million

Bunge Foods
16911 S Normandie Ave
Gardena, CA 90247-5437
Phone: 310-719-2600
Manufactures prepared mixes, fruit products
Sales Range: $100 to $499 Million

CA Custom Fruits & Flavors Inc
5800 Ayala Ave
Irwindale, CA 91706-6215
Phone: 818-812-6555
Terrence Hall, President
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $25 to $49.9 Million

Cadbury Beverages Inc/Motts USA
3 Pointe Dr #313
Brea, CA 92621
Phone: 714-990-9154
Manufactures apple juice and mixer products
Sales Range: Under $1 Million

California Citrus Pulp Company
PO Box 667
Lindsay, CA 93247-0667
Phone: 209-562-6008
Manufactures canned and frozen citrus products and juice bases for the baking, condiment, confectionary, dairy, flavoring and food manufacturers
Sales Range: $1 to $4.99 Million

California Custom Foods Inc
PO Box 2695
Lodi, CA 95241-2695
Phone: 209-369-3333
Robert W Brewer, President
Processes canned fruits and vegetables
Sales Range: Under $1 Million

California Day-Fresh Foods Inc
533 W Foothill Blvd
Glendora, CA 91741-2476
Phone: 818-852-2500
Richard Bennett, President
Fruit and vegetable juices, fresh and frozen
Sales Range: $5 to $9.99 Million

Cantisano Foods Inc
1776 Park St
Selma, CA 93662-3622
Phone: 209-896-7536
Processes tomato based sauces
Sales Range: Over $500 Million

Carol Hall's Hot Pepper Jelly Co
330 N Main St
Fort Bragg, CA 95437-3406
Phone: 707-961-1422
Carol T Hall, Owner
Manufactures canned jams, jellies, mustards, salsa, dressings, chutney, syrups and herbs
Sales Range: Over $500 Million

Carriage House Fruit
PO Box 1390
Watsonville, CA 95077
Phone: 408-722-7022
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $1 to $4.99 Million

Christopher Ranch
305 Bloomfield Ave
Gilroy, CA 95020-9516
Phone: 408-847-1100
Don Christopher, President
Fresh garlic; jarred chopped and crushed garlic; pesto, salsa, fresh peeled garlic
Sales Range: $10 to $24.9 Million

Cliffstar Corporation
11751 Pacific Ave
Fontana, CA 92335-6951
Phone: 909-685-1700
Manufactures juices and drinks-- apple, cranberry, grape, grapefruit, orange and pineapple
Sales Range: $1 to $4.99 Million

Colusa County Canning Company
6229 Meyers Rd
Williams, CA 95987-5800
Phone: 916-473-2871
Manufactures bulk paste, tomato paste
Sales Range: $10 to $24.9 Million

Consolidated Food Mgmt Corp
3198 Airport Loop Dr
Costa Mesa, CA 92626-3407
Phone: 714-708-2349
Manufactures pasta, noodles and sauce
Sales Range: $25 to $49.9 Million

Contadina Foods Inc
PO Box 2030
Woodland, CA 95776-2030
Phone: 916-662-8661
Produces tomato products
Sales Range: $1 to $4.99 Million

Country Fresh Products
PO Box 1324
Sonoma, CA 95476-1324
Phone: 707-996-2073
Christine Williams, Owner
Manufactures and packages fruit juice
Sales Range: $5 to $9.99 Million

Cowboy Caviar
28362 Marguerite Pkwy #11
Mission Viejo, CA 92692-3725
Phone: 714-364-2242
Gail Farrell, Owner
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $25 to $49.9 Million

Crown Processing Company
PO Box 1
Bellflower, CA 90707-0001
Phone: 562-865-0293
J H Bowen, President
Processes citrus rind
Sales Range: $5 to $9.99 Million

Custom Pack Inc
11800 Cardinal Cir
Garden Grove, CA 92643-3817
Phone: 714-534-5353
Robert DeCasas, President
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $1 to $4.99 Million

Del Monte Foods
PO Box 193575
San Francisco, CA 94119-3575
Phone: 415-247-3000
Brian W Haycox, Co-Chairman
Manufactures and distributes canned fruits, vegetables, juices, nectars, fruit juice drinks and snack cups
Sales Range: $100 to $499 Million

Del Monte Foods/Plant 1
PO Box 576008
Modesto, CA 95357-6008
Phone: 209-527-3850
Manufactures, distributes, processes and cans tomatoes
Sales Range: $1 to $4.99 Million

Del Monte Foods/Plant 25
PO Box 7
Kingsburg, CA 93631-0007
Phone: 209-897-2901
Cans peaches, zucchini and corn
Sales Range: $1 to $4.99 Million

Del Monte Foods/Plant 3
PO Box 69
San Jose, CA 95103-0069
Phone: 408-291-2400
Processes and cans fruits
Sales Range: Under $1 Million

Del Monte Foods/Plant 33
PO Box 30190
Stockton, CA 95213-0190
Phone: 209-466-9011
Processes and distributes peaches
Sales Range: $1 to $4.99 Million

Delta Space Corporation
681 S Clarence St
Los Angeles, CA 90023-1112
Phone: 213-268-8897
Maurice Portnoy, President
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: Under $1 Million

Diana Fruit Co
651 Mathew St
Santa Clara, CA 95050
Phone: 408-727-9631
Eugene C Acronico, President
Processes cherries
Sales Range:

Dole Food Company Inc
PO Box 5132
Westlake Village, CA 91359-5132
Phone: 818-879-6600
David A De Lorenzo, President
Grows and produces fresh and packaged fruits and vegetables, juices and nuts (corporate office)
Sales Range: $10 to $24.9 Million

Dole Fresh Vegetables Company
PO Box 1759
Salinas, CA 93902-1759
Phone: 408-422-8871
Lawrence S Kern, President
Grows and processes fresh and value-added vegetables
Sales Range: $1 to $4.99 Million

Dole Packaged Foods Co
PO Box 5500
Thousand Oaks, CA 91359-5500
Phone: 818-874-4000
Peter S Nolan, President
Produces packaged fruits, juices and nuts
Sales Range:

E Waldo Ward & Son
PO Box 266
Sierra Madre, CA 91025-0266
Phone: 818-355-1218
Richard H Ward, Owner
Manufactures specialty preserves, jams and jellies
Sales Range: $50 to $99.9 Million

El Toro Food Products Inc
109 Lee Rd #B
Watsonville, CA 95076-9422
Phone: 408-728-9266
Richard Thomas, President
Manufactures canned salsas, sauces and vegetables
Sales Range: $10 to $24.9 Million

Escalon Packers Inc
1905 McHenry Ave
Escalon, CA 95320-9601
Phone: 209-838-7341
Tomato processor
Sales Range: $1 to $4.99 Million

Fruit Fillings Inc
2531 E Edgar Ave
Fresno, CA 93706-5410
Phone: 209-237-4715
Stephen Norcross, President
Manufactures fruits, jams and jellies in pails
Sales Range: $100 to $499 Million

G L Mezzetta Inc
1201 E MacArthur St
Sonoma, CA 95476
Phone: 707-938-8388
Ronald Mezzetta, President
Processes mixed vegetables, onions, peppers, pickles; BBQ sauce
Sales Range: Under $1 Million

Gangi Bros Packing Co
PO Box 830
Riverbank, CA 95367
Phone: 209-869-9300
Full line of tomato concentrates and peeled products
Sales Range: $1 to $4.99 Million

H A Rider & Sons
2482 Freedom Blvd
Watsonville, CA 95076-1099
Phone: 408-722-3882
Clint Rider, Partner
Manufactures canned fruit and vegetables juices, drinks and blends; co-packs teas, juices, drinks and blends
Sales Range:

H J Heinz Company
PO Box 57
Stockton, CA 95201-3057
Phone: 209-948-2782
Tomato processing for paste
Sales Range: Over $500 Million

H J Heinz Company
PO Box 57
Tracy, CA 95378-0057
Phone: 209-832-4241
Tomato processing for paste
Sales Range: $1 to $4.99 Million

Harmony Juice Inc
1206 W Burbank Blvd #6-10
Burbank, CA 91506-1416
Phone: 818-567-6328
Hector Rivera, President
Manufactures juices, juice blends and nutritional supplements
Sales Range: Over $500 Million

Harter Tomato Products Company
PO Box 1688
Yuba City, CA 95992-1688
Phone: 916-673-3100
Chris Rufer, President
Manufactures and distributes canned tomato paste
Sales Range: $10 to $24.9 Million

Heinke's Inc
PO Box 369
Chico, CA 95927-0369
Phone: 916-891-1517
Bill Knudsen, President
Natural fruit juices
Sales Range: $1 to $4.99 Million

Hunt-Wesson Inc
1645 W Valencia Dr
Fullerton, CA 92833
Phone: 714-680-1000
Dave J Gustin, President
Manufactures and markets Hunt's, Wesson, Peter Pan, LaChoy, Rosarita, Healthy Choice and other food products
Sales Range: $5 to $9.99 Million

Hunt-Wesson Inc
554 S Yosemite Ave
Oakdale, CA 95361-4037
Phone: 209-847-0321
Manufactures Hunt's, Wesson, Peter Pan, LaChoy, Rosarita, Healthy Choice and other products

Sales Range: $10 to $24.9 Million

Sales Range: $25 to $49.9 Million

Ingomar Packing
PO Box 1448
Los Banos, CA 93635-1448
Phone: 209-826-9494
Gerald Stoltenberg, Partner
Manufactures and distributes tomato paste
Sales Range: $100 to $499 Million

J R Wood Inc
1117 K St
Sanger, CA 93657-3200
Phone: 209-875-3354
Manufactures, distributes and sells fruit products
Sales Range: Over $500 Million

Juicy Whip Inc
15845 Business Center Dr
Irwindale, CA 91706-2053
Phone: 818-338-5339
Gus Stratton, President
Manufactures and distributes fruit juice concentrate
Sales Range: $25 to $49.9 Million

Kagome USA Inc
1825 S Grant St #600
San Mateo, CA 94402-2662
Phone: 415-349-2271
Nobu Komiya, President
Manufactures tomato-based food service products-- catsup, spaghetti sauces; tea, juices and soft drinks
Sales Range: $100 to $499 Million

King Kelly Marmalade Co Inc
PO Box 1
Bellflower, CA 90707-0001
Phone: 562-865-0291
J H Bowen, President
Produces orange marmalade and jams

Knott's Berry Farm Foods
PO Box 1989
Placentia, CA 92670-0889
Phone: 714-579-2400
Will Lyn, President
Jams and jellies; salad dressings
Sales Range:

Kozlowski Farms
5566 Gravenstein Hwy N
Forestville, CA 95436-9609
Phone: 707-887-1587
Manufactures specialty food products--
jams, salad dressings, 100% fruit spreads,
butters and chutney, mustards and vinegars;
grows fresh berries and organic apples
Sales Range: $50 to $99.9 Million

Kraft Foods Inc/Capri Sun
2494 S Orange Ave
Fresno, CA 93725-1328
Phone: 209-441-8515
Manufactures canned fruits and vegetables,
jams, jellies and juices
Sales Range: $1 to $4.99 Million

L & A Juice Co Inc
16195 Stephens St
City of Industry, CA 91745-1718
Phone: 818-336-1666
Nathan Langer, President
Bottled and canned fruit juices, soft drinks
Sales Range: Over $500 Million

La Victoria Foods Inc
PO Box 3884
City of Industry, CA 91744-0884
Phone: 818-333-0787
Robert C Tanklage, President
Canned and bottled Mexican food
specialties (corporate office)
Sales Range: Over $500 Million

LDS Cannery
4720 Mercury St
San Diego, CA 92111-2103
Phone: 619-569-8400
Manufactures tomato paste and sauce
Sales Range: $25 to $49.9 Million

Los Gatos Tomato Products
PO Box 429
Huron, CA 93234-0429
Phone: 209-945-2700
Processes tomato paste
Sales Range: Under $1 Million

Ludfords Inc
8728 Utica Ave
Rancho Cucamonga, CA 91730-5115
Phone: 909-948-0797
Paul Ludford, President
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: Over $500 Million

Manzana Products Co Inc
PO Box 209
Sebastopol, CA 95473-0209
Phone: 707-823-5313
Constance Sandborn, President
Manufactures, distributes and sells apple juice and applesauce
Sales Range: $100 to $499 Million

Miss Scarlett Inc
PO Box 1488
Burlingame, CA 94011-1488
Phone: 415-340-9600
Peggy Luper, President
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $1 to $4.99 Million

Moline Mfg Co Inc
510 E Arrow Hwy
San Dimas, CA 91773-3341
Phone: 909-599-7113
Gary Moline, President
Manufactures fruit and vegetable juice
Sales Range: $100 to $499 Million

Monterey Mushrooms
PO Box 818
Morgan Hill, CA 95038-0818
Phone: 408-779-4191
Food agribusiness; processes mushrooms
Sales Range:

Monterey Mushrooms
260 Westgate Dr
Watsonville, CA 95076
Phone: 408-763-5300
Shah Kazemi, President
Food agribusiness; grows and ships fresh mushrooms
Sales Range: $10 to $24.9 Million

Mooney Farms
1220 Fortress St
Chico, CA 95973
Phone: 916-899-2661
Steve Mooney, Partner
Manufactures sun dried tomato products, sun dried tomatoes in olive oil and sun dried tomato pesto
Sales Range: Over $500 Million

Morning Star Packing Company
13448 Volta Rd
Los Banos, CA 93635
Phone: 209-826-8000
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $100 to $499 Million

Nasco Gourmet Foods Inc
14752 Franklin Ave
Tustin, CA 92780
Phone: 714-731-5000
Manufactures salsa, coleslaw and fresh salads (sales office)
Sales Range:

Naturipe Berry Growers
PO Box 1703
Gilroy, CA 95021-1703
Phone: 408-842-7166
Processors, vegetables and fruits
Sales Range:

Naturipe Berry Growers
PO Box 1630
Watsonville, CA 95077
Phone: 408-722-2430
Larry Shikuma, President
Grows and processes fruits and preserves
Sales Range: $1 to $4.99 Million

Nestle Beverage Co
6140 Stoneridge Mall Rd #175
Pleasanton, CA 94588-3233
Phone: 510-416-4600
Manufactures and wholesales coffee, cocoa and juice (sales office)
Sales Range: $1 to $4.99 Million

Nestle Food Company/Contadina
10652 Jackson Ave
Hanford, CA 93230-9552
Phone: 209-582-3271
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $10 to $24.9 Million

Nielson Citrus Products Co Inc
15621 Computer Ln
Huntington Beach, CA 92649-1607
Phone: 714-892-5586
Chris L Nielsen, President
Manufactures lemon and lime juice--frozen, non-pasteurized, pasteurized and shelf stable
Sales Range: $25 to $49.9 Million

Oasis Foods Inc
3381 Steven Creek Blvd
San Jose, CA 95117
Phone: 408-247-6650
Chas R Bocks Jr, President
Canned fruits
Sales Range: $10 to $24.9 Million

Old Ranchers Canning Co Inc
PO Box 458
Upland, CA 91785-0458
Phone: 909-982-8895
Donald P Graber, President & GM
Custom canners of poultry, meat, vegetables, seafood and olives
Sales Range: $25 to $49.9 Million

Olive Seville Company
PO Box 7
Strathmore, CA 93267-0007
Phone: 209-568-2113
Cans and sells olives, fruits and vegetables
Sales Range: $1 to $4.99 Million

Orange Bang Inc
8600 Tamarack Ave
Sun Valley, CA 91352-2592
Phone: 213-875-3215
David Fox, President
Manufactures and distributes natural fruit beverages
Sales Range: $100 to $499 Million

Pacific Coast Producers
PO Box 880
Lodi, CA 95241-0880
Phone: 209-334-3352
Manufactures and wholesales canned fruits and vegetables
Sales Range: $10 to $24.9 Million

Pacific Coast Producers
PO Box 1600
Lodi, CA 95241-1600
Phone: 209-367-8800
Larry D Clay, President
Manufactures and wholesales canned fruits and vegetables (corporate office)
Sales Range: $100 to $499 Million

Pacific Coast Producers
PO Box 32
Oroville, CA 95965-0032
Phone: 916-533-4311
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: $10 to $24.9 Million

Paramount Juice Company
1961 E Vernon Ave
Vernon, CA 90058-1610
Phone: 213-846-5950
Dotson Bennett, President
Manufactures fresh fruit juices for beverages and cooking ingredients
Sales Range: $1 to $4.99 Million

Pepsi-Cola Bottling Co
7550 Reese Rd
Sacramento, CA 95828-3707
Phone: 916-423-1000
Manufactures Pepsi products-- soft drinks, bottled juices and water
Sales Range: $10 to $24.9 Million

Pokka Beverages Inc
1201 Commerce Blvd
American Canyon, CA 94589-9616
Phone: 707-557-0500
M Kaklhara, President & CEO
Manufactures, exports and imports wholesale beverages-- soft drinks, juices, wines, coffees and teas
Sales Range: $50 to $99.9 Million

Procter & Gamble
1230 N Tustin Ave
Anaheim, CA 92807-1617
Phone: 714-630-6251
Manufactures Sunny Delight citrus punch
Sales Range: $25 to $49.9 Million

Quality Assured Packing Inc
PO Box 55308
Stockton, CA 95205-8808
Phone: 209-931-6700
Processes tomatoes
Sales Range: Over $500 Million

Red Wing Co Inc/California Div
PO Box 49009
San Jose, CA 95161-9009
Phone: 408-259-4800
Preserves, jellies, peanut butter, table syrups, fountain fruit and tomato products
Sales Range: $1 to $4.99 Million

River Ranch-Los Angeles
777 S Mission Rd
Los Angeles, CA 90023-1012
Phone: 213-588-4203
Processes vegetables
Sales Range: $100 to $499 Million

S & W Fine Foods Inc
5010 Loma Vista Ave
Los Angeles, CA 90058-3299
Phone: 213-588-3141
Processes and distributes canned fruit and vegetables; coffee; packaged nuts
Sales Range: $25 to $49.9 Million

S & W Fine Foods Inc
4900 Hopyard Rd Ste 285
Pleasanton, CA 94588-3347
Phone: 510-734-9750
Manufactures canned beans and potatoes
Sales Range: Over $500 Million

S & W Fine Foods Inc
736 S Mariposa Rd
Modesto, CA 95354-4115
Phone: 209-578-3882
Manufactures canned beans and potatoes
Sales Range: $10 to $24.9 Million

Safeway Inc
1111 Marina Blvd
San Leandro, CA 94577-3364
Phone: 510-613-2929
Manufactures, distributes and sells canned fruits and vegetables, jams and jellies, juices and salsa
Sales Range: Over $500 Million

Sam's Juice Company
14402 Bond Ct
El Cajon, CA 92021-2849
Phone: 619-561-2000
Manufactures fresh fruit juices
Sales Range: $10 to $24.9 Million

Saticoy Foods Corp
PO Box 4547
Ventura, CA 93007-0547
Phone: 805-647-5266
Jerry Hensley, President
Peppers and pimentos
Sales Range: $100 to $499 Million

Seville Olive Co
663 S Anderson St
Los Angeles, CA 90023-1197
Phone: 213-261-2218
Louis Pavlic, President
Olive packers, onions, cherries, and peppers
Sales Range: Over $500 Million

Simply Fresh Fruit Inc
PO Box 21328
Los Angeles, CA 90021-0328
Phone: 213-747-7774
Mark Strongin, President
Manufactures canned fruits
Sales Range: $25 to $49.9 Million

SK PM Corp
PO Box 160
Lemoore, CA 93245
Phone: 209-924-6500
Fred Salyer, President
Manufactures and sells bulk, bins and drums of tomato paste and diced tomatoes
Sales Range: $25 to $49.9 Million

Squeeze Fresh Juice Inc
PO Box 21443
Los Angeles, CA 90021-0443
Phone: 213-623-5013
Robert Goldberg, President
Manufactures, distributes and sells bottled juices
Sales Range: $10 to $24.9 Million

Stanislaus Food Products Co Inc
PO Box 3951
Modesto, CA 95352
Phone: 209-522-7201
Bob Ilse, President
Canned tomato products
Sales Range: $10 to $24.9 Million

Stone Cellar Kitchens
5821 Wilderness Ave
Riverside, CA 92504-1004
Phone: 909-352-5713
Richard Harris, Co-Owner
Produces jams and jellies
Sales Range: $25 to $49.9 Million

Sun Garden Packing Co
PO Box 6180
San Jose, CA 95150-6180
Phone: 408-283-8200
Richard L Di Napoli, President
Canned fruits and vegetables
Sales Range: Over $500 Million

Sunkist Growers Inc
PO Box 3720
Ontario, CA 91761-0993
Phone: 909-983-9811
Canned juices and citrus products
Sales Range:

Sunkist Growers Inc/San Joaquin
PO Box 99
Tipton, CA 93272-0099
Phone: 209-752-4284
Bulk citrus processing facility (orange concentrate)
Sales Range:

Sunny Farms Corp
2400 Florida Ave
Richmond, CA 94804-2822
Phone: 510-620-0280
Jose Gatchalian, President
Produces fruit juices and mineral water
Sales Range:

Super Store Industries
8001 Red Top Rd
Vallejo, CA 94589-9747
Phone: 707-864-0502
Manufactures and bottles fluid milk, juice
Sales Range: Over $500 Million

The Barlow Company
PO Box 1579
Sebastopol, CA 95473-1579
Phone: 707-823-6401
Thomas Barlow, President
Manufactures and sells apple juice and apple sauce
Sales Range: Over $500 Million

The J M Smucker Company
PO Box 81447
Salinas, CA 93912-1447
Phone: 408-424-2761
Jams, jellies, preserves, fruit butters, syrups
Sales Range: $25 to $49.9 Million

The J M Smucker Company
PO Box 2730
Watsonville, CA 95077-2730
Phone: 408-722-8181
Frozen fruit; strawberries, oranges, apples, peaches, apricots and industrial fruit products
Sales Range: Over $500 Million

Trader Vic's Food Products Co
PO Box 8603
Emeryville, CA 94662-0603
Phone: 510-658-9722
Lynn Bergeron, President
Non-alcoholic cocktail mixes, syrups, salad dressings
Sales Range: $1 to $4.99 Million

Tri Valley Growers
PO Box 511
Los Banos, CA 93635-0511
Phone: 209-826-1970
Cans tomatoes; processes cherries and fruit juices
Sales Range: Under $1 Million

Tri Valley Growers
PO Box 7114
San Francisco, CA 94120-7114
Phone: 415-837-4000
Joseph Famalette, Pres & CEO
Packers, canners; grower-owned food processing organization
Sales Range: $5 to $9.99 Million

Tri Valley Growers
3200 E Eight Mile Rd RR2
Stockton, CA 95212
Phone: 209-931-8000
Tomato canning; processes cherries and fruit juices
Sales Range: $5 to $9.99 Million

Tri Valley Growers
PO Box 108
Thornton, CA 95686
Phone: 209-794-2303
Processes tomato products
Sales Range: $10 to $24.9 Million

Tri Valley Growers
426 N 7th St
Sacramento, CA 95814-0210
Phone: 916-442-4144
Processed foods; peaches, fruit cocktail
Sales Range: $1 to $4.99 Million

Tri Valley Growers/Plant R
PO Box 1211
Modesto, CA 95353-1211
Phone: 209-572-5511
Manufactures canned fruits and vegetables, jams and jellies
Sales Range: Under $1 Million

Triple H Foods
5821 Wilderness Ave
Riverside, CA 92504
Phone: 909-352-5713
Thomas Harris, President
Produces sauces, bar mixes and juices
Sales Range: $100 to $499 Million

Tropical Preserving Company Inc
1711 E 15th St
Los Angeles, CA 90021-2715
Phone: 213-748-5108
Ronald Randall, President
Preserves, jellies and pancake syrup
Sales Range: $100 to $499 Million

Valley Tomato Products
760 Industrial Dr
Stockton, CA 95206-3927
Phone: 209-982-4586
Processes tomato paste exclusively for Campbell's soups
Sales Range: $25 to $49.9 Million

Van den Bergh Foods Co
5776 Stoneridge Mall Rd #190
Pleasanton, CA 94588-2836
Phone: 510-463-0606
Manufactures food products (sales office)
Sales Range: $100 to $499 Million

Van den Bergh Foods Co
PO Box 9200
Stockton, CA 95208-1200
Phone: 209-466-9580
Processes tomatoes (plant)
Sales Range: Over $500 Million

Van den Bergh Foods Co
PO Box 2168
Merced, CA 95344-0168
Phone: 209-723-8831
Manufactures canned specialties, tomato paste
Sales Range: $1 to $4.99 Million

Vita-Pakt Citrus Products Co
PO Box 309
Covina, CA 91723-0309
Phone: 818-332-1101
William Robinett, President
Manufactures, distributes citrus products
Sales Range: $1 to $4.99 Million

Voila Juice Company
4240 Hollis St
Emeryville, CA 94608-3508
Phone: 510-658-3806
Gary Boland, Owner
Manufactures fresh fruit juices
Sales Range: $25 to $49.9 Million

Walker Foods Inc
237 N Mission Rd
Los Angeles, CA 90033-2103
Phone: 213-268-5191
R Walker, President
Manufactures tomato hot sauce, vinegar and chili
Sales Range: $10 to $24.9 Million

West Coast Products Corp
PO Box 623
Orland, CA 95963-0623
Phone: 916-865-3379
Estelle Krackov, President
Olives and olive oil
Sales Range: $5 to $9.99 Million

Western Shore Orchard Inc
PO Box 75
Hood, CA 95639-0075
Phone: 916-775-1637
Sarah Simpson, President
Manufactures and sells dehydrated pear products, jam, jellies and vinegar
Sales Range: $10 to $24.9 Million

World Citrus West Inc
PO Box 797
Fullerton, CA 92632-0797
Phone: 714-870-6171
Manufactures fruit juices and drinks
Sales Range: $50 to $99.9 Million